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Designing Augmented Reality-Based Multimedia Using Experimental Methods to Improve Students' Cognitive in Basic Network Subject

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ABSTRACT

This study aims to determine the cognitive increase that occurs in students, after being given treatment in the form of learning using-based learning multimedia Augmented Reality with VAK (learning models Visualization, Auditory, Kinesthetic) in Basic Network subjects. The subjects of this study were students of class X (ten) at one of the vocational schools in the district, West Bandung. The background of this research is the learning model used previously in the teaching process is less effective, the multimedia used by the teacher is too monotonous and the lack of understanding and student activity in the learning process. The research method used in this research is quantitative and the teaching method used is experimental. While the application development method used is SHM (Comprehensive Life Cycle) and the results obtained from this study are: 1) Interactive multimedia is considered good and suitable for use. The presentation score was 83.99% which was interpreted as "Very good" by media experts and teachers, 2) The interactive multimedia can also improve students' cognitive and obtained an average gain value of 0.67 with the "Medium" effectiveness criteria. Meanwhile, the students' response to the based on Augmented Reality-based multimedia obtained an average score of 81.19% and is included in the "Good" category.

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1. INTRODUCTION

The use of technology in the classroom has succeeded in changing the image of learning in the classroom, because thanks to educational technology, the classroom is no longer a boring place and learning can be fun. The use of media in classroom teaching is a need that cannot be ignored (Umar, 2017). One of the efforts that must be taken is how to create a learning situation that allows the process of learning experience to occur in students by mobilizing all learning resources and effective and efficient learning methods. In this case, learning media is one of the effective supports in helping the learning process occur (Rahma, 2019; Hingide *et al*., 2021). The number of subjects that must be mastered, sometimes makes students bored and tends to be careless in learning even though they have been given freedom in the process. Moreover, limited facilities, infrastructure and media make teachers must provide more on their own interactive media. This is experienced by high schools and vocational schools in Indonesia.

Practical experience is more sought in the learning process for vocational high school student, including in Basic Network subjects. The practices in basic network learning requires many tools and materials. Given that the average number of students in one class is around 30-35 students, these tools and materials are not easily accessible due to its high price. This causes a limited number of tools used in practice, so the student has to take turns while using the tools. In addition, the modules itself have their own problem. Sometimes there are students who do not understand the module and tend to get bored if they only see pictures and writing, so that students' understanding is lacking compared to using videos and animations or other media that are more interesting.

This problem is also a common problem experienced by various schools, both public and private schools. The results of a field study at one of the private schools in Bandung City which became the practice place of the researchers' Field Experience Program in the 2019/2020 school year revealed that 37% of students who filled out the questionnaire agreed that the Basic Network subject is a difficult subject. Basic Network subject is hard to understand and the school has limited number of computer, causing quite a number of students unable to follow the learning process. This was supported by the results of questionnaires distributed to students and it was found that 78% of respondents stated that learning computer network media was less interesting with the constraints of media used too often such as whiteboards and modules, this was also supported by the results of interviews with the teachers concerned.

To improve the quality of learning, educational application software with the help of multimedia-based computers is needed. In this modern era, students need the latest innovations in learning, where current learning modules can be combined with the latest technological developments. One such technology is Augmented Reality. Old modules that only contain writings and a few images can be combined with two-dimensional or three-dimensional virtual which will create interactive learning modules, which are creative, interesting, and innovative. With the help of this Augmented Reality, the problem of limited number and fragile tools used for practice will be minimized. Students can learn and understand the material and can see animations or 3D learning objects before using the actual tools (Utami *et al*., 2015). The problem of teaching modules that are less innovative and interesting can also be overcome, because this AR-based interactive module will be able to attract students' learning interest to help and facilitate students' understanding of learning materials, especially in the realm of memorization, understanding and application.

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With technology, it must be supported by appropriate learning models so that assessment instruments for students can be achieved. Therefore, the proposed learning model is VAK (Visualization, Auditory, Kinesthetic). Learning with this model emphasizes direct and fun learning experiences for students (Rukmana *et al*., 2018). Direct learning allow students to study by remembering (visual), learning by hearing (auditory), and learning by motion/emotion (kinesthetic). Therefore, students do not only read and practicum, but also fun. This goes hand in hand with vocational high school learning process, whose learning process is divided into 70% practice and 30% theory.

One of the goals of this study was to obtain cognitive improvement based on pretest and posttest scores. To get the pretest and posttest scores, an experimental teaching method was used by dividing students who were research subjects into two groups, namely the control class that used conventional learning models and the experimental class which was treated in the form of VAK learning models and augmented reality-based multimedia learning.

2. METHODS

This research uses quantitative research methods and SHM (Comprehensive Life Cycle) multimedia development model. Both methods are suitable based on the consideration of researchers to develop multimedia based on existing problem formulations because in quantitative research, the problems brought by researchers must be clear. This research procedure is described in **Figure 1**.

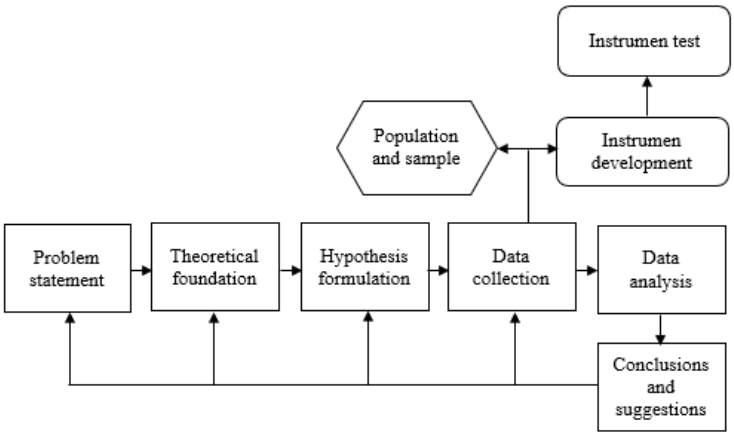

Figure 1. Quantitative research procedures.

2.1. Theoretical Foundation

The theoretical basis of this study is to conduct analysis by making direct observations by asking the teacher concerned. Observations were made to grade 10th students who were studying basic networking subjects by asking all students to fill out a questionnaire some time before the lesson ended.

2.2. Research Methods

The independent variables in this study are VAK learning models through experimental methods and conventional learning models through lecture or conventional methods. The variables tied to this study are the results of learning cognitive aspects and memorizing, understanding and applying. The controlled variables in this study were learning materials, teachers who used *augmented reality* and those who did not use it between experimental

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classes and control classes with VAK learning models. The research design used in this study is presented in **Table 1**.

Tabel 1. Research design.

Group	*Pretest*	Treatment (Independent Variable)	*Post test* (Dependent Variable)
Experiment	Y1	$X_{experiment}$	Y2
Control	Y1	$X_{lecture}$	Y2

Description:
Xexperiment = Learning Basic Networks using the VAK learning model through experimental methods using augmented reality.
Xlecture = Learning Basic Networking by using VAK learning model through lecture method.
Y_1 = Basic Networking initial proficiency test.
Y_2 = Basic Networking final proficiency test.

2.3. Multimedia Development Model

The multimedia development model that will be used is the Comprehensive Life Cycle Model (SHM). It consists of five stages, namely Analysis, Design, Development, Implementation, and Assessment. Phases of the Comprehensive Life Cycle (SHM) model for multimedia software development in education are shown in **Figure 2**.

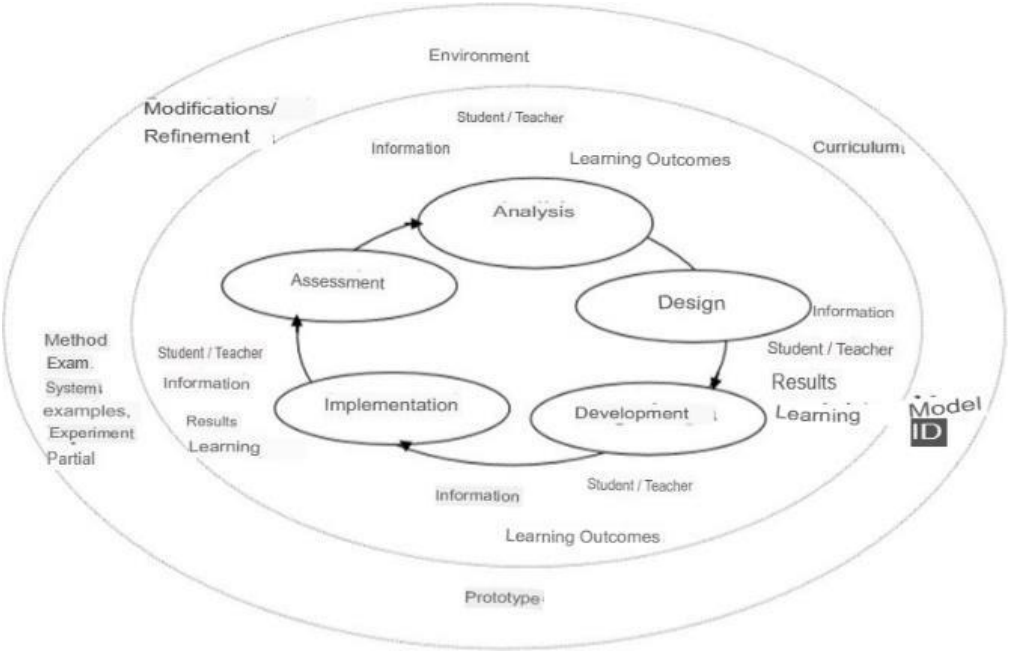

Figure 2. SHM model.

2.3.1. Analysis stage

Needs analysis is a process to obtain information and specifications about the software that users want, namely Teachers and Students. Both parties, namely the *client* and the software maker are actively involved in this stage. Information from the client will be the reference for software design. Needs analysis is the first step to determine the picture of the device that will be produced when researchers carry out a software development project, namely in this case interactive multimedia. Good software that suits the needs of users largely depends on the success in conducting a needs analysis.

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2.3.2. Design stage

At this stage, researchers compile material and make question instruments and make a storyboard and flowchart.

(i) Marker Making

The researchers create 3d models and their respective AR marker.

(ii) Preparation of materials and question instruments

The preparation of the material aims to be later included in the learning media, while the making of question instruments is used for Pretest and Posttest at the implementation stage. In this study, the analysis technique used is a quantitative method approach that is useful to see students' cognitive improvement by their grades. Data from the assessment instrument is taken from the results of testing first on the students concerned so that pretest and post test scores are obtained.

(iii) Flowchart Preparation

The researcher create flowchart that shows the sequence and relationship between processes and their instructions in interactive multimedia based on Augmented Reality.

(iv) Storyboard Drafting

The researcher plan a visual for the interface in the form of a storyboard. This interface illustrates what things will be created in interactive multimedia based on Augmented Reality.

(v) Student Response Instrument

The researchers create questionnaire for the student to determine the students respond after using the application.

2.3.3. Development stage

At this stage, the application will be developed and must contain the learning material, such as Computer Network materials based on the VAK (Visual, Auditory, Kinesthetic) learning model. The augment reality-based multimedia is designed to have good visual elements, clear audio and students certainly must actively participate in using interactive multimedia to accommodate VAK model. The multimedia is also designed to have built-in quiz and exercise for the student to engage.

After the multimedia is finished, the next step is to ensure the multimedia feasibility through expert validation. If the multimedia is deemed not feasible, the researchers will revise the multimedia.

2.3.4. Implementation stage

After Augmented Reality-based multimedia is deemed feasible based on validation by experts and improvements have been made, then the next stage is the implementation stage. Before the actual test was carried out, two trials were carried out, namely the first stage of testing and the second stage of testing. The first stage of testing was carried out on students who had studied Basic Network subjects. This trial is carried out to determine the disadvantages, advantages, and constraints of the product.

From the results of these trials, there are shortcomings which will then be revised for further testing in the second stage. All students are given the freedom to use multimedia applications in class creatively and innovatively through individual and group approaches and are given the freedom to ask their teachers about what they want to know. Before and after using the multimedia, students were given tests in the form of multiple-choice questions to

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find out an increase in their understanding after using the multimedia. In addition, students were also given questionnaires to find out their responses to multimedia.

2.3.5. Assessment stage

At this stage, researchers get input in the form of comments and suggestions from experts and students so that the interactive multimedia is even better. Student response instrument, this instrument aims to determine the assessment of all Students who have used this interactive multimedia, including their satisfaction level and the progress they feel in the subject.

2.4. Data Analysis Techniques

In this study, the instruments used include pretest question analysis, posttest question analysis, validity test, reliability test, question difficulty test, differentiating power test, gain test, media expert validation sheet and material and student response instrument after using interactive multimedia based on augmented reality.

2.5. Population and Sample

The population in this research process is all multimedia class X students. This type of data collection uses *a rating scale* to make it easier for researchers to get the results of all students' responses.

3. RESULTS AND DISCUSSION

3.1. Field Studies and Literature Studies

Based on the results preliminary survey, it was found that 51.1% of the 44 students who were respondents stated that the Basic Network subject was a difficult subject because it a lot of student's grade are below the passing grade. This is presented in **Figure 3**. The reasons that cause these problems are material that is difficult to understand, inadequate learning media and a boring learning process.

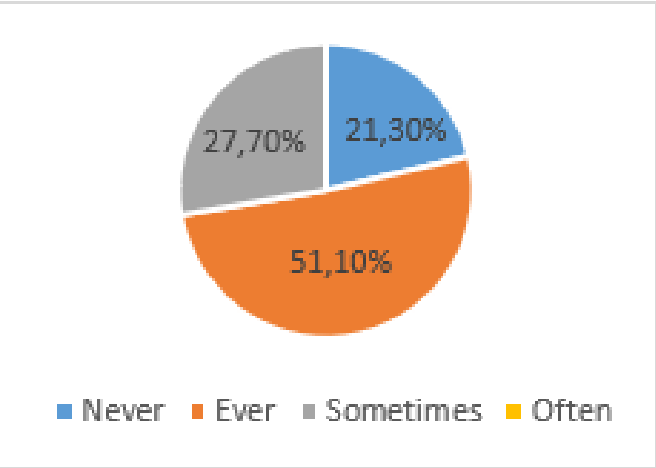

Figure 3. Student grades.

The next question is about the purpose of the media and it resulted as 42.8% of students said that they felt that the multimedia helped them in learning and 44.7% said it was very helpful. This is presented in **Figure 4**.

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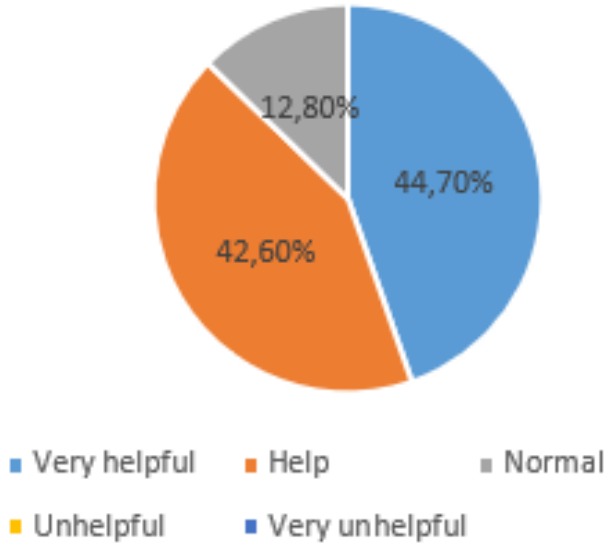

Figure 4. Desired learning media.

The next question asked about the devices the student used. Based on the result, the device that is often used by students is a smartphone 93.6%, adding more evidence for researchers to create mobile-based interactive multimedia. This is presented in **Figure 5.**

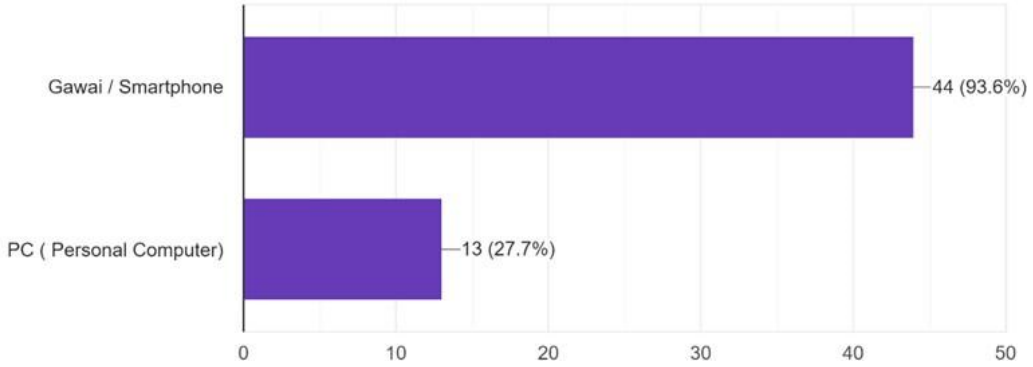

Figure 5. Frequently used devices.

3.2. Needs Analysis

(i) Researchers must be able to make applications that can help in Basic Network subjects, namely applications whose contents vary and refer to Visual – Auditory can also make it easier for grade X Multimedia 1 and 2 students to understand the material.
(ii) Utilizing the habits of grade X Multimedia 1 and 2 students who often use devices (smartphones) in their daily lives. That is to create a mobile-based application *so* that it can be opened and learned anywhere.

3.3. Multimedia Inferface

3.3.1. Start page

In this main menu, users will see various menu options, namely the 1) Main menu, 2) Information menu, 3) Material menu, 4) Quiz menu, 5) About menu and 6) Quit menu while listening to the backsound. When the user selects the main menu, it will automatically enter the *AR Camera*. Here users only need to point the smartphone camera to the available

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markers. Users can also see about info or explanations of objects on the screen. In addition, if the user is unable to read, they can select the sound button option to hear the explanation of the object**.** Users can also turn on and turn off these buttons. The initial page view can be seen in **Figure 6**. If the user selects the main menu, it will look like **Figure 7**.

Figure 6. Main menu.

Figure 7. Menu main.

3.3.2. Information and quiz menu

In the Information Options Menu, there is an image source that the developer references**.** There are also Basic Competencies, which are reference materials for making applications based on the existing vocational "kurtilas" syllabus. There is also the purpose of making this application. The information page display is presented in **Figure 8**.

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Figure 8. Information menu.

When selecting the quiz menu, questions will automatically appear that must be done by the student. There are 20 questions in total. If they answer only one question incorrectly, the final grade will come out immediately. This serves so that users can repeat many times to fill in all the available questions so that later they will understand and remember the material. If the user is able to answer all the questions, the value that will be obtained is 100 points. The quiz page is presented in **Figure 9**.

Figure 9. Quiz menu.

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3.3.3. Material menu

In the selection menu of this material there is material about Wiring. The student do not have to sequentially select the material they want to learn. This material menu is useful to support students understanding obtained from the main menu. There is also a video option for the materials. The material menu display is presented in **Figure 10**.

Figure 10. Material menu.

3.3.4. About and Help menu

The student can read about the full profile of the developer and the research supervisor. The about page view is presented in **Figure 11**.

Figure 11. About menu.

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There are instructions for use, which is how to use this application. The help page is presented in **Figure 12.**

Figure 12. Help menu.

3.4. Question Data Analysis

The pretest and post test questions were tested for validity by the lecturer, namely Rizky Rachman J., M.Kom. as a lecturer in the computer network course and by the teacher involved, namely M. Yuga Wira Praja A., S.Pd. By looking at the suitability of the questions with basic competencies, achievement indicators and question types including C1, C2, C3 and so on. Then if there are questions that are not appropriate, the Lecturer or Teacher can fill in the column of improvement suggestions. This is done to determine the feasibility of question items so that they can be used as a test benchmark. After the eligibility is approved, the question is tested on students. In this study, the questions were tested on 44 students. After obtaining the results of the question test on students, then the researcher conducted a test of validity, reliability, level of difficulty and discriminating power. The result of the decision stated that out of 40 multiple-choice questions, 22 questions were used, and 18 questions were not used. Questions that are not used are based on tests of validity, difficulty and discriminating power. The question that is said to be feasible is if the level of validity is sufficient, high, and very high, but the question is categorized as inappropriate if it has a low and very low valitidas level. A sample table of the results of the question analysis is presented in **Table 2**.

Table 2. The results of the question analysis.

No	r(xy)	Level of validity	Difficuly level	Difficuly status	Differentiating power	Dfferentiating power status	Decision
1	0.63	High	0.52	Medium	0.92	Very good	Use
2	0.37	Low	0.68	Medium	0.50	Good	Not use
3	0.49	Enough	0.55	Medium	0.58	Good	Use
4	0.30	Low	0.66	Medium	0.50	Good	Not use
5	0.57	Enough	0.50	Medium	0.50	Good	use

3.5. Material and Media Validation Data Analysis

The finished media was then tested for validity by the lecturers, namely Rizky Rachman J., M.Kom. and Dr. Wahyudin, M.T. and by the teacher, namely M. Yuga Wira Praja A., S.Pd. Assessment of material and media using the LORI (*Learning Object Review Instrument*)

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assessment instrument in which there are several aspects of assessment including the quality of content or material, alignment of learning objectives, feedback and adaptation, motivation, presentation design, ease of use, accessibility, and reusability. The assessment results showed an overall average score of 83.99%, which means that the media is included in the "Very Good" category.

3.6. Experimental Results

Based on the results of experimental teaching methods, this study was conducted on 44 respondents, 22 students from control classes and 22 students from experimental classes. The data generated from the experiments that have been carried out are obtained pretest, posttests and student responses. The experimental class pretest and posttest value data obtained are presented in **Figure 13**.

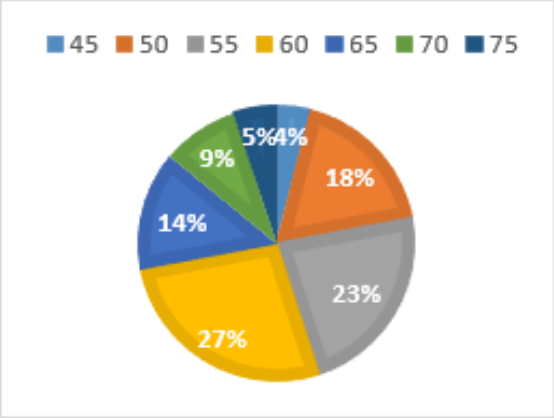

Figure 13. List of experimental class grades.

The results of the class gain test are presented in **Table 3**.

Table 3. Experimental class gain test results.

x̄ pretest	***x̄ post test***	***x̄ gain***	**Level**	**Effectiviness**
58,64	93,09	0,84	High	Effective

3.7. Student Responses to the Use of Multimedia

Student responses to learning using interactive multimedia based *on Augmented Reality* are quite good. With an average score of 81.19% and included in the "Very Good" category. This is in line with the average cognitive results obtained using interactive multimedia. This value is obtained based on the questionnaire distributed and uses calculations with the *rating scale* presented in **Figure 14**.

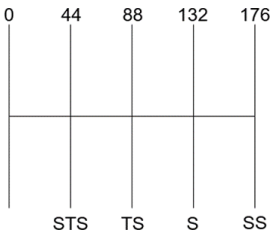

Figure 14. Rating scale of student opinions.

Information:

STS (Very Disagree), TS (Disagree), S (Agree) and SS (Very Agree).

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4. CONCLUSION

Students' cognitive improved after using augmented reality-based interactive multimedia in basic networking subjects, especially on computer network media materials. This is evidenced by the average gain value in the experimental class of 0.84 which is interpreted into "high" effectiveness. As for the control class of 0.51 which falls into "Medium" effectiveness. It can be concluded from the acquisition value that the use of the model and multimedia in all classes with a value of 0.67 is interpreted in the level of effectiveness of "Medium" effect on learning.

Student responses to learning using interactive multimedia based on Augmented Reality are quite good. With an average score of 81.19% and included in the "Very Good" category. This is in line with the average cognitive results obtained using interactive multimedia.

5. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

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